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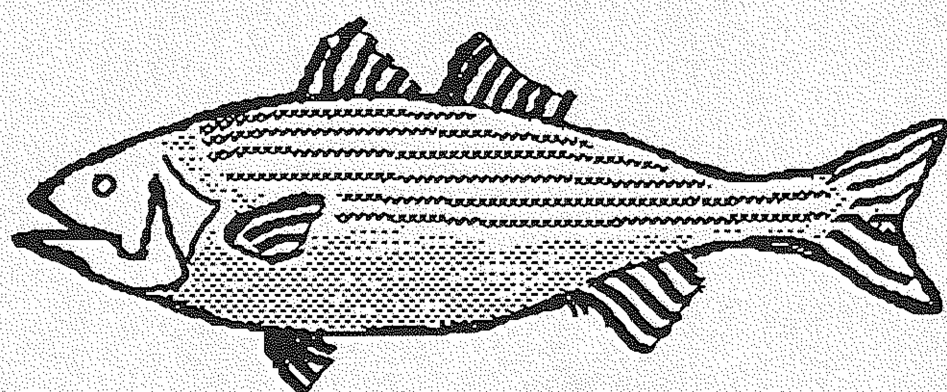
An Economic Analysis of Freshwater Finfish Aquaculture in the Mid-Atlantic States



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ABSTRACT

Aquaculture is a rapidly emerging industry in the United States. Farmed catfish is the fourth largest single species contributor to the total edible fish product in the U.S. Aquaculture has been practiced for thousands of years, but it is only in the last 15 years that containment produced fish have begun to contribute significantly to the fresh fish supply.

The stability of the ocean fish catch is uncertain. The fisheries for species traditionally favored by Americans have reached or surpassed sustainable catch levels. Other species are currently underutilized. However, if the catch of these fish is increased, their contribution to total supplies may not keep pace with demand. Per capita consumption of fish in the United States is rising steadily. The gap between supply and domestic demand is widening, and It is being filled by imports of both fresh and frozen fish.

Given the large urban population in the Mid-Atlantic states, New York, Pennsylvania, and New Jersey, it has been assumed that a tremendous opportunity exists for regional aquaculture producers to supplant imports and capture the local market. Until now, this notion has not been thoroughly tested.

The objectives of this study are to provide a descriptive analysis of the freshwater finfish aquaculture industry in the Mid-Atlantic states, to estimate the profitability of current enterprises, and to assess the potential for the expansion of aquacultural production in the region. To this end a survey of 188 freshwater finfish farmers in the Mid-Atlantic states was conducted. Eighty six individuals were contacted and 30 useable surveys were obtained.

Results indicate that the majority of regional producers continue to supply the traditional sportfishing "stocking" market. Pay-to-fish ponds are an important additional source of income. Over 40% of the 30 survey respondents sell fresh food fish through various market channels. Middlemen, wholesalers, and retailers are generally avoided so that producers may capture the value added through direct sales to consumers and restaurants. Survey respondents favor raceway and earthen pond grow-out technologies. There is increasing interest in water recirculation technologies. However, most enthusiasts are postponing investment in these systems until it is proven that they can be managed profitably.

The two businesses analyzed that employ traditional grow-out technologies are profitable enterprises. Facility investment ranges from $2,200 to $160,000, generating annual net returns to labor, management, and equity of $23,000 and $63,000, respectively. These figures represent individual cases. Further study is required to gauge the profitability of regional aquaculture as a whole. A successful business employing water reuse technology was not identified. However, most observers of the aquaculture industry in the Mid-Atlantic states agree that, due to the general lack of sites with significant water supplies, recirculation technologies hold the greatest promise for the expansion of regional production.

The legal and regulatory environment in the three Mid-Atlantic states is not fully supportive of the emerging aquaculture industry. Regulations governing the transport of live fish and controlling the effluents of fish farms impede business operations. Official designation for aquaculture as an agricultural, rather than an industrial, undertaking, with state and federal agriculture departments established as lead agencies, is expected to alleviate the bureaucratic cobweb that currently restricts the industry.

AN ECONOMIC ANALYSIS OF FRESHWATER FINFISH AQUACULTURE IN THE MID-ATLANTIC STATES

SECTION ONE - INTRODUCTION

This is a study of the freshwater aquaculture industry in the Mid-Atlantic states. The population of this region, comprised of New York State, New Jersey, and Pennsylvania, was 37.2 million in 1985.[1] Regional per capita fish consumption exceeds the 1988 national average of 15 pounds per capita by 150%.[2] This level of consuption places regional demand for seafood in the neighborhood of 837 million pounds of fish per year. Mid-Atlantic fishermen had a total catch of 163 million pounds in 1987.[3] Hence, local production supplies only about 20% of demand. Certainly, a large amount of fish is brought in from neighboring states. However, on the national level 56% of the fish consumed in 1988 was imported.[4] The ocean catch of traditionally consumed fish species is rapidly reaching maximum sustainable yields. Fishermen cannot bring in greater amounts of fish without risking serious depletion of these wild stocks. They must spend increasing amounts of money, time, resources, and technology just to maintain current catch levels. Some observors argue that increasing the harvest of currently under-utilized species offers some relief to this supply constraint. This assertion is countered with the argument that all species play an essential role in maintaining fisheries ecology. They are a part of the environmental system that enables catches at current levels. Increasing the harvest of these "underutilized" species will further threaten the fisheries resource.

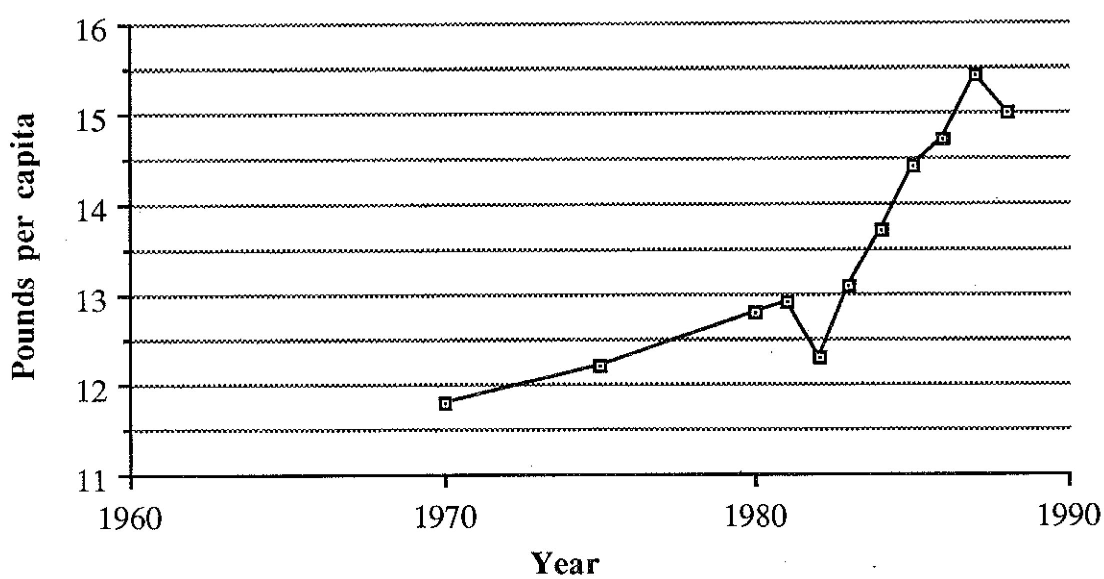

Figure 1. Per Capita Consumption of Fish in the United States, 1970 - 1987

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[1]United States Department of Commerce, 1986, p. 505.
[2]Personal communication, Joe Regenstein, Professor of Food Science at Cornell.
[3]USDA, 1988, p. 519.
[4]USDC, 1989, p. 67.

Meanwhile, the demand for fish continues to rise. This is partly a function of rising population and rising incomes, but, more importantly, it is a reflection of changing consumer preferences. Fish is perceived to be a healthier form of protein than red meat. It contains omega-3 fatty acids which are said to lower blood serum cholesterol. Increased demand will result in further shortfalls in local production, leading to a rise in imports.

During the 1980's the cry has been raised to supplant these imports with locally produced farmed fish. Reduced distribution costs and the ability to provide greater customer services would enable local aquaculturists to compete with imported fish products. This rationale is compelling, but the details of the argument have not been examined. It is also not known in what numbers and with what degree of success entrepreneurs have responded to this opportunity.

The emphasis of this study is on the aquacultural production of fish for the food market. It is the ability of fish farmers to directly supply fish to regional markets that has generated so much interest in recent years. The food market offers the greatest potential for growth in the regional aquaculture industry. Traditionally, all government fish rearing activities and a significant percentage of private operations have been oriented towards raising fish for the stocking of lakes, ponds, and streams. This appears to be a relatively slow growth market. Barring a significant increase in the popularity of freshwater sportfishing and backyard fish ponds, the fish stocking market is likely to be limited to annual repeat sales.

Until recent technological developments allowed the culture of fish in controlled environments, fish farming in the Northeast has been confined to the culture of cold water species. The trout is foremost among the species chosen for grow-out.

1.1 A BRIEF HISTORY OF TROUT AQUACULTURE

The practice of aquaculture predates historical record. The Chinese have raised fish in ponds for over three thousand years, and there is evidence of fish rearing in Pharaohs' Egypt. Modern trout culture, however, stems from the more recent discovery of artificial propagation methods by two Frenchmen, Joseph Remy and Antoine Gehin, in 1842. Based on their observations of trout in the wild, they designed streambed hatching boxes in which they placed fertilized trout eggs (Fry, 1854). Their methods quickly took hold, leading to the establishment of commercial fish propagation facilities across Europe (Davis, 1953). The first successful attempt at the artificial propagation of trout in the United States occurred in 1857. Fish cultural practices were soon expanded to include species of salmon and shad.

By 1870 "some 200 private persons (in the U.S.) were practicing fish culture, either as a business or as a hobby."[1] Commercial culturists sold fish eggs and fry for stocking and table fish to the local urban markets. "Table trout sold for $1 per pound, at a time when the going wage was $1 per day."[2] However, the rehabilitation of wild fisheries was to take precedence over the propagation of fish as a profit-making enterprise.

The American Fish Culturists Association (which was to evolve into the American Fisheries Society) was formed in 1870. The stated goal of the Association was to foster the development of propagation methods and the dissemination of fish culturing information. By improving and promoting the science of artificial fish propagation, these men hoped to restore freshwater fisheries and anadromous fish runs. The Association

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[1]Benson, p. 1.
[2]Ibid, p. 73.

strongly advocated the creation of United States Commission of Fish and Fisheries. The Commission soon gained primacy over the Department of Agriculture in matters of fish culture and fisheries conservation. "The result was a federal fish culture agency oriented toward natural resources rather than to the agricultural industry. The precedent was set for the stocking of public waters with fish produced by the government instead of fish purchased from private producers."[1] The state and federal governments were to take and keep the predominant role in fish-culture activity in the United States.

Private commercial hatcheries did not emerge from this shadow until the second half of the century. The advent of inexpensive pelleted feeds in the early 1960's helped push trout production levels up from 2 to 3 million pounds per year in the 50's to 18 to 20 million pounds in 1968.[2] During the 1970's, aquaculture output in the United States increased significantly. This was a time of great enthusiasm during which the emerging role of aquaculture in providing protein for the masses was widely heralded (Bardach et al., 1972; Sea Grant, 1985). By the end of the 70's, it was apparent that these expectations for U.S. aquaculture would not be rapidly met.

In 1975 the U.S. share of total world aquaculture production was a mere 1% (Schatz, 1978). The development of U.S. aquaculture was impeded by economic constraints such as "low prices or limited markets for products; high prices or limited availability of purchased inputs such as sites, capital, unskilled labor, and trained managers...and the great quantity of purchased inputs necessary to produce output."[3] Schatz cites a National Research Council (NRC) report on "Aquaculture in the United States: Constraints and Opportunities" which found that U.S. aquaculture "has been devoted to luxury food species that are, for the most part, high on the food chain, fed prepared diets high in animal protein, and grown in intensive production systems... Success with this approach has, at best, been marginal for economic reasons."[4] The NRC called for the introduction of new species, the development of new closed-system technologies, the investigation of polyculture systems, and the development of alternative feeding practices. Together with the efforts of a federal lead agency (to be designated) to cut a path through conflicting state and federal regulations and to facilitate the provision of financing at reasonable terms, these developments would help to assure the steady growth of aquaculture in America. In the intervening years the implementation of this prescriptive program has been steady, but slow. Still, the potential for "the use of aquaculture for universal production of a low-cost source of protein...is quite low... Production of low cost species, for the most part, is not at this point economical... Aquaculture development will most probably take place in higher-value species."[5]

In 1980 trout farmers "in nine surveyed states[6] sold 48 million pounds of foodsize trout."[7] Idaho aquaculturists produced 89% of this total. California and Pennsylvania, respectively, had the next highest shares of total output. The majority of sales in Pennsylvania were to fee fishing and recreational markets (USDA, 1981). In 1988 "trout

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[1]Benson, p. 81.
[2]Benson, p. 89.
[3]Schatz, p. 8.
[4]Ibid, p. 7.
[5]New York Sea Grant Institute, p. 12.
[6]Alabama, Arkansas, California, Georgia, Idaho, Missouri, Pennsylvania, Washington, and Wisconsin.
[7]United States Department of Agriculture, September, 1981, p. 11.

producers surveyed by USDA sold 58.9 million pounds with a value of $63.6 million."[1] The vast majority of trout sold by commercial producers across the nation were food size. Fee fishing output for 1988 is estimated at an additional 20 million pounds of trout.

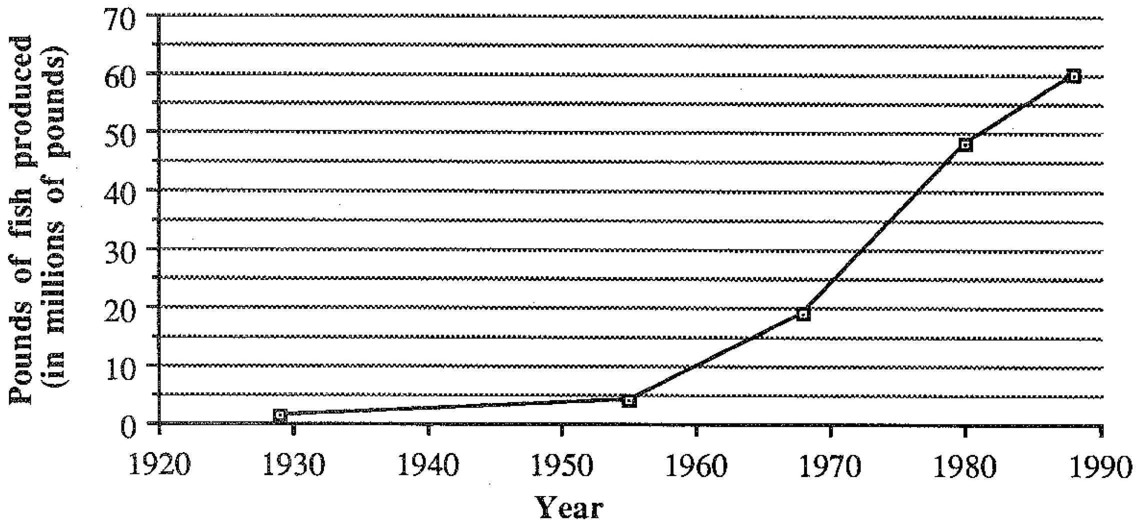

Figure 2. Trout production levels in the United States, 1929-1988

The number of trout farmers surveyed nearly doubled between 1981 and 1988 (USDA, 1989). Idaho remains the largest producer of trout. It has a small number of large firms that are vertically integrated and efficiently managed. Most importantly, Idaho has significant supplies of high quality water. "There are smaller production centers in other western states and along the Appalachian Mountains from New York to Georgia."[2]

1.2 THE OBJECTIVES OF THIS STUDY

The objectives of this study are:
1) To provide a descriptive analysis of the freshwater finfish aquaculture industry in the Mid-Atlantic states.
2) To estimate the profitability of a variety of freshwater finfish aquaculture enterprises.
3) To appraise the potential for the expansion of freshwater aquaculture in the Mid-Atlantic states.

1.3 METHODOLOGY

In the last week of May, 1989, a 10 page survey was mailed to 188 individuals. These individuals were identified by consulting the membership lists of the New York Aquaculture Association and the nascent New Jersey Aquaculture Association and by obtaining the Pennsylvania state list of fish propagation license holders. Neither the New Jersey list nor the Pennsylvania list specified the activities of those listed. Many individuals on the New Jersey list, for instance, are merely interested in aquaculture. There was no way of telling whether the individuals listed were directly involved in commercial freshwater finfish aquaculture. Hence, with the omission of those who clearly were not engaged in commercial fish farming, the entire lists from Pennsylvania and New Jersey were surveyed. No attempts at statistical randomization were made. Surveys were mailed to every individual identified as a potentially active producer of freshwater finfish.

[1]USDA, 1989, p. 3.
[2]Ibid, p. 10.

Thirty useable surveys were returned. The responses to each question are presented in the following chapter. No statistical procedures were used in the manipulation of this data. In essence, a census of producers was attempted. The results fall short of this goal. Yet, a defined profile of the industry in the Mid-Atlantic region was achieved. Twenty-nine or 73% of the forty New York State individuals identified were contacted. The New York State Aquaculture Association's list is fairly comprehensive. It is unlikely, the Association's president insists, that many producers of significant scale are not Association members. There is so little going on in the way of commercial freshwater aquaculture in New Jersey that significant producers are not easily overlooked. No useable surveys were received from New Jersey producers, but the two active freshwater aquaculturists identified were contacted by phone. Twenty-seven of the seventy-three (37%) individuals identified in Pennsylvania were contacted. The head of the Pennsylvania Aquaculture Association, which was formed while this study was being conducted, gave assurances that the largest producers in the state had been contacted.

Ten of the respondents particpated in follow-up interviews. These ten were chosen, because they represent a diversity of production technologies, output levels, and marketing strategies. The information gathered in these interviews provides the basis for the financial analyses, marketing studies, and discussions of producer concerns presented in the following chapters.

SECTION TWO - SURVEY RESULTS AND ANALYSIS

Of the 188 potential aquaculture producers identified, the activities of 86 were ascertained. Forty seven of these 86 returned surveys, and 39 people were reached by telephone. The remaining 102 individuals were either unreachable by phone, after five attempts, or they reside in areas too thinly populated to be included in the Tompkins County Public Library microfiche phonebook files (which are more up-to-date and more extensive than the files in the Cornell library). The activities of the 86 people reached are broken down as follows:

Commercially active fish producers:	40
30 returned surveys	
10 were reached by phone	
Producers who have gone out of business:	16
Shellfish farmers (New Jersey):	10
Planned freshwater operations:	6
Hobbyists:	5
Producers of aquaculture inputs:	3
Purveyors of ocean-caught fish:	3
Producer of ornamental fish:	1
Refusals to participate:	2
Total	86

The information from the 30 relevant surveys received is summarized below. Data is covered question by question, following the sequence of the survey instrument. Information received from telephone conversations and from in-person interviews is incorporated in subsequent chapters.

2.1 MANAGEMENT

Of the 30 respondents 15 operate their businesses on a part-time basis, earning an average of 12.4% of their income from their sideline. The remaining 15 operations are full-time.

The professional background of the 30 ranges from wildlife conservation and biology to commercial fishing, engineering, and restaurant management. Most respondents listed short courses offered by state colleges and on-site experience as the basis of their operational expertise.

Twenty two of the aquaculturists raise trout, mostly rainbows with some brook, brown (*Salmo trutta*), and tiger (*Salmo tigris*) as well. One respondent raises Coho (*Oncorhynchus kisutch*) and Atlantic salmon (*Salmo salar*) and another raises Coho smolts (juvenile salmon, physiologically adapted to life in the marine environment)[1] in addition to trout. Four growers produce large (*Micropterus salmoides*) and small mouth (*Micropterus dolomieui*) bass. Two raise Channel catfish (*Ictalurus punctatus*). Two raise striped bass (*Morone saxatilis*); one grows tilapia (*Tilapia spp.*); and one respondent did not specify his chosen species.

Spring is the principle season of harvest. As the marketing data will reveal later, most of the respondents are engaged in fish stocking activities. Eighteen respondents harvest in the spring. 14 harvest in the summer, 12 in the fall, and 1 in the winter.

Fish weighing less than half a pound are most likely sold for stocking purposes. Trout weighing half a pound or more could be destined for either the stocking or food markets. Catfish and Tilapia may not legally be released in the wild. They are grown entirely for food purposes.

Table 1. Species Selected for Grow-Out and Their Target Harvest Weights

Species Grown	No. of Growers	Target Harvest Weight
Trout	1	45-100 fish/lb
	3	6-8 oz
	6	12 oz
	3	1 lb
	1	4 lb
	4	various weights
Bass (freshwater)	5	3 oz (fingerlings)
(Stripers)	2	unspecified
Salmon	2	various weights
Catfish	2	3 lb
Tilapia	1	1 lb

The majority of producers responding to the survey raise their fish in ponds and/or raceways. These are the traditional means for raising trout and freshwater bass, the two species most widely chosen for grow-out by the respondents. Grow-out technologies are discussed in greater depth in Chapter Three.

Table 2. Types of Grow-Out Facilities used by Respondents

Type of Facility	No. of Growers
Cages	6
Ponds	21
Raceways	19
Recirculation systems	5

[1]Piper et al., p. 496.

Respondents were asked to rank their fish-culture facilities as either extensive, semi-intensive, or intensive. These terms describe both the grow-out facilities employed and the manner in which they are managed. Ponds, for example, can be managed extensively with low stocking densities and low rates of turnover, or when managed as "earthen raceways" they could be considered semi-intensive. Recirculation systems with their high stocking densities, high turnover rates, high management requirements, and complicated technology are considered intensive. The majority of respondents operate concrete and earthen raceways in the production of trout.

Table 3. Level of Fish Culture Intensity

Level of Intensity	No. of Growers
Extensive	2
Semi-intensive	21
Intensive	7

Twenty two of the respondents have on-site hatcheries; this is a strategy of producers engaged in stocking sales and of food fish culturists attempting to develop selected strains of fish. At least one respondent who sells fish for stocking buys in fertilized fish eggs from a west coast supplier. Three respondents have on-site processing facilities.

Each respondent has an average of 11.7 acres devoted to aquaculture (this figure is skewed upward from 7.8 acres by one report of a 120 acre facility).

2.2 PRODUCTION LEVELS

Production levels, both real and projected, are reported in Table 4. Not all respondents reported production figures. Some of the respondents were not producing in 1987 and 1988. Others do not keep harvest records; these producers tend to sell their fish by the inch and not by the pound. They engage primarily in stocking sales to sportsmen's organizations and private pond owners. This partial reporting indicates a steady growth in output through 1995.

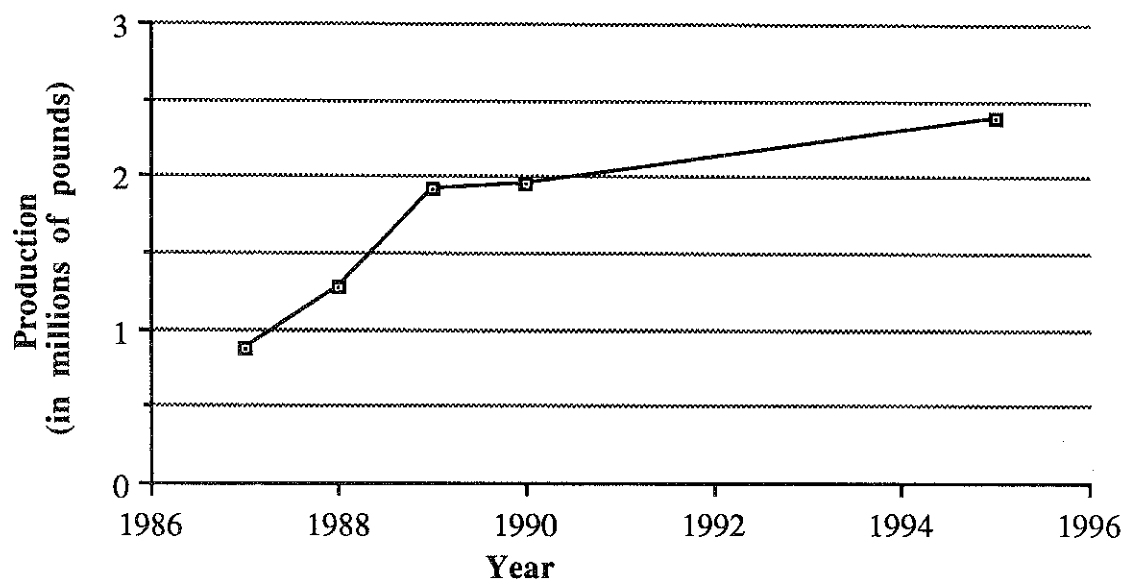

Figure 3. Fish Production as Reported by Survey Respondents, 1987 - 1995

2.3 FEED

Clearly, growers favor dry pelleted feed over all other forms of feed (Table 5). As Table 6 indicates, this is true during all growth stages in the fish life cycle.

Table 4. Types of Fish Feed Used by Growers

Type of Feed Used	No. of Growers
Dry feed	27
Semi-moist feed	4
Moist feed	2
Wet feed	1
Live feed*	6

*Live feed ranges from crayfish and minnows fed to trout to daphnia (water fleas) fed to freshwater bass.

The average conversion ratio of feed to live weight gain is 1.9:1 for dry feed (min: 1.25:1; max: 3:1). The average conversion ratio for semi-moist feed is 1.25:1 (based on 2 reports). No conversion rate calculations were reported for the other types of feed used.

Table 5. Types of Fish Feed Used at Various Life Stages

	Egg-fry	Fry-smolt	Smolt-adult
Dry	19	19	21
Semi-moist	4	2	3
Moist	2	3	0
Wet	1	1	0
Other (live)	5	1	1

The fertilized trout egg develops and then hatches; from this time until it has reached 1 inch in length the fish is known as a fry. Subsequently, juvenile fish are referred to as fingerlings; this term describes "the stage in a fish's life between 1 inch and the length at 1 year of age." A smolt is a juvenile anadromous salmonid, physiologically prepared to enter the marine environment.[1]

Less than half of the growers use growth enhancing technologies. Of these technologies, temperature control and oxygen injection are favored. Insufficient levels of dissolved oxygen retard fish growth rates. However, super saturation can be injurious to the fish. Gravity aeration refers to the use of oxygenating water spouts powered by gravity water flow.

Table 6. Use of Growth Enhancing Methods at Various Life Stages

	Fry-smolt	Smolt-adult	Adult
Temp. Control	7	3	3
O2 injection	5	5	5
Computer feeding	0	0	0
Hormones	1	0	0
Gravity aeration	2	2	2
Fertilizer	1	1	1

[1]Piper et al., p. 481.

2.4 CULTIVATION PROBLEMS

Two growers reported problems with net fouling. This problem occurs in the summer and early fall. It is caused by excess vegetation and can be controlled by daily maintenance of nets and screens.

Three growers experienced trouble with filter fouling. Detritus and algae are the culprits. The problem occurs daily in the summer and less frequently throughout the rest of the year.

Nineteen respondents (63%) are plagued by predators. Heron are the principal culprits, but kingfishers, blackbirds, osprey, hawks, and mink are equally damaging. Depredation can occur daily in all seasons in unsheltered facilities.

Fourteen growers (47%) have disease problems. These include furunculosis, bacterial gill disease, columnaris, red spot, fin rot, spawning fungus, parasites, and ammonia toxicity. Overcrowding and infection by external agents such as birds are the main causes listed. Diseases occur with varying frequency in the summer and fall.

Six respondents have problems with ice in winter. Low temperatures result in ice-clogged screens and in oxygen loss. January and February are the worst months.

Four of the aquaculturists have trouble with algal blooms. Warm water and fertilization are the causes indicated. The problem occurs regularly in summer months. One grower of bass actually encourages algae which his fish feed on.

Four growers have pollution problems. These are caused by highway run-off, acid rain, and inadequate filtering of fish fecal wastes. Frequency and season of incidence vary according to cause.

Other cultivation problems noted include lack of water, which occurs regularly in the summer, and siltation, which most likely occurs in the spring.

Growers consider depredation to be the most severe cultivation problem. Some growers reported losing over a quarter of their fish to predators in a single year. Fish diseases rank a close second. Of course, any problem that results in direct fish mortality poses a threat to producers. By the time a fish reaches saleable size, significant monetary value is incorporated in its flesh.

Table 7. The Most Severe Cultivation Problems

Cultivation Problem	No. of Growers
Depredation	8
Disease	7
Warm water	2
Acid rain	2
Ice	1

2.5 MARKETING AND SALES

The total amount of fish produced by the 24 respondents who reported production figures for the year 1989 was 1,912,050 lb. The percentages of this total product sold through various marketing channels are reported in Table 9 below. The third column in the table gives the percentage of reporting respondents servicing each market channel.

Stocking is the dominant market, capturing nearly 70% of total reported sales. This is followed by direct sales of food fish to restaurants and consumers and then sales through traditional wholesale and retail market channels. This breakdown of sales is the reverse of what occurs nationally. If fee-fishing sales are included, 70% of the trout produced nationally are sold as food-fish.[1]

Table 8. Market Channel Share Percentages of the Total Reported 1989 Product

Marketing channel	Percentage of Total Reported Product	Percentage of 24 Reporters[2]
Restaurants	14.2	25
Retailers	6.3	25
Wholesale	6.0	13
Mail order	0.2	(one respondent)
Cooperatives	0.6	(one respondent)
Consumers	6.5	2
Stocking	66.2	79

No sales were made to brokers, processors, or exporters. Evidently, the respondents prefer to sell directly to the highest paying customers. Few respondents have reached the scale of production where the costs of direct marketing outweigh the benefit of the value-added prices received.

Respondents list an array of preferred types of customers. There were many instances respondents' likes and dislikes in regard to customer type were exactly opposite. This could be a function of business location as well as simple individuality.

Table 9. Customers Most Preferred by Survey Respondents

Type of Customer	No. of Growers
Angling clubs and sportsmen	6
Private pond owners	5
Restaurants	3
Retailers	2
Other hatcheries & state agencies	2
Direct sales to customers	1
Fee fishing sales	1
Any sale is a good sale	3

The last group of respondents argues that a broad range of customers ensures a high level of sales, which contributes to business well-being.

[1]U.S.D.A., E.R.S., 1989, P. 10.

[2]Individual respondents market through a range of channels. Hence, the figures in the right-hand column in the chart above should be used in direct reference to their counterparts in the columns to the left; the right-hand column does not add up to 100%.

Table 10. Form and Price of Fish Sold

Form	Percentage of Total Reported Product	Percentage of Respondents	Price
Fresh	30.3	41	$3.27/lb
Frozen	0.4	(one respondent)	3.75/lb
Smoked	0.2	(one respondent)	12.00/lb
Live	69.1	79	Variable

The head of marketing at Ziegler Brothers, the largest producer of aquaculture feeds in the Northeast,[1] estimates that sales of fish raised in the Northeast are divided 50-50 between the food and stocking markets. Results here indicate a greater emphasis on "live" stocking sales.

None of the respondents claim to be ahead of their production goals. Twelve say they are right on schedule, and an equal number report that they are behind schedule.

2.6 PERCEPTION OF COMPETITION

Respondents reported market competition from the following sources:

Table 11. Sources of Regional Aquaculture Market Competition

Source of Competition	No. of Growers
Domestic aquaculturists	14
Commercial fishermen	3
State & local government	2
Foreign aquaculturists	1
Sport fishermen	1
Producers of non-fish protein	1
Traditional fisheries	0

Competition from domestic aquaculturists is likely to be high in both the stocking and wholesale fish markets. Stockers compete for sales with inter-regional growers; wholesale marketers of trout compete with the large producers in Idaho. State and local governments that operate hatcheries are potential competitors with stockers. Foreign aquaculturists export large amounts of salmon and shrimp to the United States. The U.S. used to import a large percentage of its total supply of trout as well (Scattergood, 1956). Apparently, these imports have been supplanted by U.S. production. Current import data contain no listing for trout.

2.7 CONSTRAINTS

The lack of legally unrestricted sites with adequate water flow and quality appears to be a significant obstacle to the expansion of traditional raceway aquaculture in the Mid-Atlantic states. Some respondents cite lack of funding and market uncertainty as powerful constraints to enterprise expansion. Although it has long been practiced, aquaculture remains an emerging industry in this region. Over half of the survey respondents report that their businesses are profitable. However, the number of aquaculture enterprises in the Mid-Atlantic states is still quite low. In addition these enterprises tend to be geographically dispersed. These factors contribute to a general lack of public knowledge regarding local

[1]Zeigler Bros., Inc., P.O. Box 95, Gardners, PA, 17324.

aquaculture and may foster banking industry perception of aquaculture as high risk. In many respects this perception may be accurate. There does not appear to be a formula approach to aquaculture. The individual components that shape an aquaculture enterprise, including the amount and quality of available resources, vary significantly. Many setbacks, such as disease and water source pollution, can occur by chance. Hence, even when well informed, a risk averse lender may regard investment in aquaculture as unwise.

Table 12. Constraints to Respondents' Enterprise Expansion

Constraints	No. of Growers
Lack of appropriate sites/ lack of water	9
Lack of capital funding	6
Limited market/ market uncertainty	5
Lack of time	3
Lack of information/ education	2
High cost of land in area	1
State regulations	1
Lack of desire	1

Table 13. Constraints to Aquaculture Business Profitabilty in the Northeast

Constraints	No. of Growers
Competition	6
High debt load/ limited capital/ cash flow	3
Limited market for a specialized product/ market prices	3
High costs	3
Volume*	2
"We operate on a fixed price contract"	1
It is difficult to feed bass	1

*(there is a need to spread fixed costs over greater production)

Two respondents report that they have no constraints to business expansion or profitability.

Seventeen respondents (57%) who report that they are running profitable enterprises cite the attributes listed in Table 15 below as leading to their success (some respondents listed more than one contributing factor). These attributes do not require elucidation.

Table 14. Factors Contributing to Business Profitability

Hard work	9
Careful planning/ good decision making	5
Selling the product in a high price market	4
Good water	3
Cost control/not overextended	2
Ingenuity/ common sense	2
Cleanliness	1
Cooperation with neighbors to use their idle assets (ponds, etc...)	1

Survey participants were asked to list technical innovations which would help to improve the profitabilty of their aquaculture operations. At the top of the list is oxygen supplementation. Oxygen supplementing technologies allow aquaculturists to maintain dissolved oxygen at optimal levels. This is particularly important in summer months when increased fish metabolism rates lead to rapid oxygen depletion. Apparently, available oxygen injectors are either costly or inefficient.

Waste management systems are of great import. Each of the three Mid-Atlantic states has legislation for the regulation of aquaculture effluents. Complying with these imposed standards is potentially costly. This issue is discussed in greater detail in Section Six. The remaining statements are rather self explanatory. Recirculation systems are discussed in Sectionss Three and Five; disease testing will be discussed in Section Six.

Table 15. Technical Innovations That Would Allow Increased Business Profits

Desired Technology	No. of Growers
Cost efficient oxygen supplements/ O2 injection	7
Development of cost effective waste management systems	3
Refinement of recirculation systems	2
New feeds/ production of "natural foods"	2
Improvement of automated fish cleaning devices	1
Improved automatic feeders	1
Synthetic aquifers	1
Cheap insulated buildings	1
FDA-approved fiberglass tanks	1
Development of warm water tolerance in trout	1
New grow-out techniques (none specified)	1
Development of inexpensive, non-lethal disease tests	1

2.8 PERMITS AND REGULATIONS

Fifty nine percent of the respondents reported lease and permit expenses. The average expense is $717 per year. Many respondents reported no expenses in this category.

Twenty four percent listed "once only" legal and consulting fees averaging $1720. Presumeably, these are costs incurred as part of the start-up process.

Thirty four percent of the participants reported an average of 10 months time in obtaining permits to begin construction of their grow-out facilities. There were not enough responses to the question "how many months did it take to obtain permits to begin marketing" to yield useful data.

Response to the question about the most limiting regulations and constraints varied considerably. Two respondents found the leasing and permitting process to be the most burdensome. Two listed siting and construction. Three claimed transportation regulations as the most limiting. Four said the same of marketing restrictions. Three respondents listed other limiting factors. These are FDA restrictions of chemical use (presumably for disease treatment), obtaining permits to grow out non-native species, and securing loans from finance institutions.

Less than half of the respondents identified the regulatory agencies they have to deal with in siting, fish transport and in the selling of fish. Many participants claimed that permits were not required to conduct their operations. Responses are listed in Tables 17, 18, and 19 below

Table 16. Agencies Issuing Aquaculture Site Permits

Agency	No. of Growers
New York State Department of Environmental Conservation	6
No permit necessary	5
Pennsylvania Department of Environmental Resources	2
PA Fish Commission	2
Soil and Conservation Service	1
Local town or borough	1

Table 17. Agencies Issuing Fish Transport Permits

Agency	No. of Growers
NYS Department of Environmental Conservation	4
None required	2
U.S. Department of Transportation	2
PA Fish Commission	2
"Various state fish agencies"	2

Table 18. Agencies Issuing Permits Allowing the Sale of Fish

Agency	No. of Growers
PA Fish Commission	6
NYS Department of Environmental Conservation	5
None required	2
NYS Department of Consumer Affairs	1
PA Department of Environmental Resources	1
Various state agencies	1

In response to the question, "why did you start your aquaculture operation?", 11 fish farmers answered "to take advantage of the intrinsic qualities of an existing site." Four said it was to provide labor and income for family members. Thirteen did it to provide labor and profits for themselves. Nine listed other reasons, ranging from entering the buisiness to provide profits for the corporation, to enjoy the business and the outdoors, to have an interesting hobby, and for the challenge. A fisherman started his aquaculture business in order to have fish to sell during the winter months when he is ashore. One couple who run a meat cutting business thought raising and selling fish would be a successful corallary business.

2.9 SECONDARY ENTERPRISES

Respondents listed a wide range of ideas for enterprises to couple with their existing aquaculture businesses in order to take advantage of excess labor, capital, inputs, outputs, etc. Linking recirculation aquaculture with hydroponic gardening is discussed in Chapter Four. Fee-fishing ponds are a common sales device. The full list of responses appears in Table 19 on the next page.

Many respondents attached general comments to their survey forms. These comments relate to support needs and other concerns. One grower feels that a generic marketing board should be formed to promote aquaculture products. Another respondent commented on the attitude of the New York Department of Environmental Conservation; he feels that unnecessary obstacles are thrown in the way of aquaculturists seeking to produce non-traditional species. Several fish farmers concurred. They consider the hatchery licensing process to be unnecessarily burdensome. Another respondent feels that his state's environmental conservation department is engaged in a race to tie up water resources, preventing their use by private aquaculturists.

Table 19. Secondary Enterprises Compatible with Aquaculture

Secondary Enterprise	No. of Growers
Fertilizer from waste water and solids	4
Sale of bottled spring water	2
Establishing a Christmas tree operation	2
Aquaculture consulting	1
Net making	1
Hydroponic gardening	1
Recycling organic wastes; rotating ponds	1
Design and sale of specialized fishing tackle	1
Establishing fee-fishing ponds	1
Selling fish remains to hog farmers	1
Turning fish remains into catfood	1

In summary, half of the respondents are full-time producers. Two thirds of the respondents raise trout, primarily rainbows. Ninety percent of the growers obtain an average feed to live weight conversion ratio of just under 2:1 pounds using dry feed. Depredation and disease are the most severe production problems. Seventy three percent of the aquaculturists have on-site hatcheries. Ponds and raceways are used for grow-out by the majority of producers. A half dozen respondents are trying cage culture, while a handful are tinkering with water recirculation systems. Sales are divided 70 - 30 between the stocking and food markets. Respondents perceive other aquaculturists as their chief source of competition.

SECTION THREE - A DESCRIPTION OF GROW-OUT SYSTEMS

Aquaculture grow-out facilities vary according to water flow requirements. The amount of water flow on a given site determines the range of options available to the fish farmer. The more water, the more choices a grower has in regard to what type and what quantity of facilities he/she may use. Water quality, measured in terms of "temperature, gas content, turbidity, mineral content, and freedom from pollution and possible infection from disease organisms,"[1] and water flow, measured in gallons per minute, are the two most crucial variables in fish culture. Water temperature, for instance, greatly influences the range of species that may be cultured on a given site and the rate at which the fish will grow. The volume of water flow generally determines the amount of fish that can be produced. Hatchery managers use a general rule of thumb: a given facility should be able to produce fifty pounds of fish per year for each gallon per minute of water flow.

The following list of facility types is ranked from greatest to least water flow requirement. The last, water recirculation, is the only grow-out technology that allows culturists to circumvent, to a degree, the otherwise limiting factors of water flow and water temperature imposed by a given site:

[1]Davis, p. 12.

1) Raceways
2) Ponds
3) Cages
4) Recirculation.

3.1 RACEWAYS

Raceways are used by two thirds of the survey respondents. They are favored for the production of trout. Successful operation of trout raceways requires large and steady supplies of pristine water. The raceways are almost invariably built of concrete; hence, they are relatively expensive to construct.

"Raceways are particularly suited for large installations... [They] are easier to manage and maintain than [outdoor] tanks, though in general the practice of discharging water through a series of raceways has little to recommend it from the hygiene point of view, as the lower water courses receive contaminated water from those higher up,"[1]

including, in the event of disease outbreak, water tainted with pathogens. Large raceway installations require massive supplies of water. Fish tend to congregate at the upstream end of raceways where the concentration of dissolved oxygen is the greatest. Hence, the grow-out space is not used with the greatest efficiency. "Levels of ammonia and other metabolic waste products gradually increase towards the lower end of the unit."[2] Water flow forces solids to the downstream end of the raceway, where they are relatively easy to collect. Besause of the high volume of water that passes through raceways, soluble wastes tend to be diffuse.

3.2 PONDS

"There is general agreement that concrete raceways are cheaper to maintain and operate than earthen ponds. Many fish culturists contend, however, that fish raised in dirt raceways and ponds are healthier and more colorful... Rectangular earth ponds usually are more convenient and efficient... Large ponds of irregular shapes are more difficult to clean, and it is harder to feed and harvest fish and control disease in them."[3]

The question of relative expense could be open to debate. If an operator can borrow a backhoe, as one of the survey respondents did, and dig the pond himself, construction costs would be almost non-existant. Higher pond maintainence expenses, spread over time, may be more acceptable considering these initial savings. That ponds require less water flow than raceways is certain. They are used by sixty percent of the respondents for grow-out. Ponds are used for fee-fishing operations as well.

Flexibility is one possible advantage of pond culture. Ponds can be taken in and out of operation or even "moved". In this respect the rotation of ponds, as suggested by a respondent and corroborated by McLarney (1985), can be an effective means of waste management. Ponds can be drained periodically and sown with high nutrient demand crops (presumably with shallow root systems). Waste nutrients are taken up by the plants and removed from the pond with the crop. Sale of the crops can potentially contribute to the operator's income.

Qualities of the grow-out site, other than water supply, can be important to the overall facility design. Topography is an important one. "Whatever the system to be

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[1]Stevenson, p. 42.
[2]Piper et al., p. 45.
[3]Piper et al., p. 47.

developed, the most reliable and cheapest way to circulate water is by gravity. For this, there must be a sufficient drop in ground level from intake to final outflow."[1] One respondent who produces trout and salmon has a number of ponds for grow-out with an additional pond devoted to fee-fishing. Each pond is indepedently supplied with water. Should it occur, disease will be unable to spread from pond to pond. The water derives from a bountiful uphill spring and is gravity fed to the individual ponds through underground PVC piping. Two of the ponds have gravity-powered water spouts of the owner's design. These supply additional oxygen to the two ponds. His design obviates the need for mechanical pumping and aeration and, therefore, results in significant reductions in operating costs over time.

"There are also obvious advantages in locating the (facility) near the source of the water. Among other things, the water there is under better control and requires a shorter pipeline, which lessens the expense and greatly decreases the possibility of accidents to the supply."[2] One respondent, dependent on a mountain stream for his inflow, lost half of his fish when a fuel truck crashed and ruptured upstream.

Some respondents who have high quality water feel that this is an additional asset. These fish farmers tend to live in remote regions where there is little or no industry. They contend that fish take on the taste of the water they live in. Consequently, they believe that the quality of their fish is perceivable and will be apparent to those who eat it. Urban consumers who are increasingly concerned about the health benefits of the food they eat are wary of the dangers posed by pesticides, additives, and pollutants in food. A few growers with high quality water feel that printing their water test results on the labels of shrink-wrapped fresh fish sold in supermarkets could be an effective way of reaching this growing market. This idea has not yet been tested; therefore, it's effectiveness cannot be determined. Bottling the water for sale could be a successful secondary enterprise, until the water is needed for expansion of the primary enterprise.

3.3 <u>CAGE CULTURE</u>

Cage culture "involves rearing fish in small enclosures built of wire or plastic netting stretched over a frame. The cages are attached in series to floating platforms and anchored in rivers, lakes and ponds or in protected areas along coastal shores. Water currents and wind action carry away wastes and provide fresh water. Cage culture is readily adapted to areas that cannot be drained or from which fish cannot be readily harvested,"[3] including un-seinable "wild" ponds. Harvesting fish from cages is easy. But there are many possible disadvantages. Fish cannot be protected from diseases existing in the water system. Water currents may not be sufficient to carry fish wastes away and to provide oxygenation. Plus, cages in public waterways are relatively susceptible to theft and vandalism.

If the waterway in which the cages are situated is not privately held, obtaining rights for cage culture grow-out can be difficult. State departments of environmental conservation are rightfully concerned that escaped fish may corrupt the gene pool of wild stocks or that introduced species may exert catastrophic pressures on the aquatic ecosystem (New York Sea Grant Institute, 1985). In Maine coastal residents have objected to the cage culture of salmon on aesthetic grounds (Platt, 1989). Other detractors of cage culture worry that unconsumed feeds and concentrated fish excreta will pollute the waterway floor.

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[1]Stevenson, p. 21.
[2]Davis, p. 15.
[3]Piper et al., p. 48.

An experiment involving the pond cage culture of bullheads (*Ictalurus melas*) by 30 part-time growers is currently underway in upstate New York.

3.4 WATER RECIRCULATION TECHNOLOGIES

Few sites in the Mid-Atlantic states that are naturally endowed with large supplies of high quality water remain unutilized. Most of these freshwater supplies are reserved for other uses, principally human consumption. Many of the sites that are available tend to be remotely located. From the standpoint of strategic marketing these sites are less desirable. In response to water supply limitations a number of people involved in the aquaculture industry in the Northeast are attempting to develop and perfect grow-out technologies that use water more sparingly. By continuously filtering and reusing the water that passes through the culture medium, water recirculation systems can potentially produce large volumes of fish by reusing a relatively small amount of water.

Because of their low flow requirements, recirculation technologies would allow culturists to expand the limits imposed by low water availability.

"Recycled systems have the potential to offer a number of important advantages for aquaculture production, including controlled environments, relative freedom from site and water supply constraints, control over disease agents and temperature-controlled growth rates and production."[1]

Consisting of a series of tanks usually placed indoors, recirculation systems could be located almost anywhere. As Timmons et al. (1987) suggest, the ability to locate near large metropolitan areas gives recirculation systems a significant marketing advantage over producers located outside the region.

The essential challenge of recirculation design is to develop a system that can deliver marketable size fish on a consistent, regular basis and at a reasonable cost. While many technological factors must be brought together to form a smoothly functioning system, the biological waste-water filters are generally regarded as the most crucial design component. These filters, of various design, provide a growing surface for beneficial bacteria which convert harmful nitrites to non-toxic nitrates. Most filter designs are subject to clogging, which impairs the efficiency of the system and occassionally results in high fish mortality.

Producing market sized fish at regular intervals throughout the year requires craft and manipulation. The simplest way to raise fish in an enclosed system would be to introduce the fingerlings, feed them, and then harvest them when they reached the desired size. Such a "once through" approach to recirculation culture is grossly inefficient. Only when the fish reach market size would the system be operating at full capacity. Until that point a significant percentage of tank volume and water filtering capacity would be unutilized. By consistently separating fish of different size and, hence, different growth rates into different tanks, a recirculation culturist can maximize the efficiency of his system while creating several staggered groups of fish that will arrive at market size at different times. Introducing new lots of fingerlings, so that fish of different ages and growth stages are being grown-out simultaneously, is further means of achieving this end.

Water reuse or recirculation systems are the most technically complex of all grow-out systems. Many researchers have attempted to perfect the technology, but few appear to have done so. Some designs are both technically and economically infeasible. Others

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[1]Muir, p. 435.

involve high installation and operating costs which render them economically marginal for the grow-out of all but the most valuable species.

"There have been few completely successful recycle units for outgrowing, and most have been employed for the raising of relatively valuable early stages [of a fish's life cycle]. The small profit margins available with many cultured species and the uncertainty of costs, risks, and returns in recycled systems have contributed to this."[1]

Written in 1982, these words still apply today. However, the feeling within the aquaculture industry in the Northeast is that recirculation technologies hold the greatest promise for the expansion of fish farming in the region. Consequently, the race is on to perfect the technology.

Because recirculation technology has been considered economically marginal for so long, each new "breakthrough" claimed by a researcher is generally regarded with skepticism. Too often such doubts are justified, as many new designs are revealed to be mere reshufflings of old components and fail to result in greater cost efficiency or improved technical performance. Because the profit potential is so great for the individual who develops a problem-free and financially feasible recirculation system, those who claim breakthroughs are highly secretive about their designs, generally refusing to share design information until they obtain patent protection. As a result,

"there is no defined 'status of closed-system aquaculture'. University research remains limited to the study of pilot-scale prototypes, without the means to integrate the dozens of components and system technologies involved. And if an industry actually intends to invest in the research and development of the technology before it proceeds (a rare situation), it will certainly not share its results. Therefore, there is not a significant, reliable information base available describing the status of many of these components, or the related technologies."[2]

This lack of information gives rise to speculation; recirculation technology is not without detractors. Many observers claim the fish grown in reuse systems have off-flavors. Recirculation water filter systems do not remove all of the fish wastes. Rather, they remove solids, while converting harmful nitrites to non-toxic nitrates. As a consequence, the water in the fish tanks is murky. This murkiness may cause people to infer that the fish raised in such water are of inferior quality. To the contrary, taste tests, conducted as part of the Cornell study (Timmons et al., 1988), indicated total consumer acceptibility of fish raised in their recirculation system.

Recircualtion technology also raises financial concerns. Many of the survey respondents consider the technology to be too risky. The Cornell system is low cost, but its neoprene-lined plywood tanks do not inspire confidence in these observors; perhaps they don't believe the plastic will hold up, or they fear that the liner will make the fish taste funny. The survey respondents also balk at the high investment required to secure the proprietary technology offered by private researchers. For these people, who are already engaged in fish production, recirculation will remain for the immediate future a promising but unproven technology. However, if fish production is to expand significantly in the Northeast, increased attention must be paid to the development of recirculation technology. Many survey respondents commented on the lack of sites with adequate water supplies. Some stated that access to most ideal sites is usually blocked by state departments of

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[1]Muir, p. 435.
[2]Van Gorder, p. 2.

environmental conservation. This underlines the need for water conserving grow-out technologies.

Very few have been able to put together recirculation systems that can bring in table size fish at a cost low enough to enable competitive pricing. As a result, many people involved in the study of aquaculture insist that the time for recirculation has not yet come. These people argue that recirculation technologies cannot be economically feasible until the price of fish is driven up by increased demand in the face of a dwindling ocean catch. Two survey respondents disagree. They argue that the information required to design economical and functional recirculation systems is available in the literature. They inist that with proper management systems they have developed can generate a steady cash flow sufficient to enable payoff of the initial investment within five years. Of course, the details of their systems are proprietary.

A third respondent is a retired engineer who attempted to couple a water recirculation system with a hydrponic greenhouse. The fish would supply the necessary nutrients to the vegetables, while the vegetable root systems and the perlite substrate they attach to would filter the nitrogenous wastes from the fish water. As it turned out, this system works better in theory than in practice. The vegetable side of the scheme worked well. Fish manure yielded better quality produce than the conventional hydroponic ammendments. The fish did not fare as well. In winter months the greenhouse cannot heat the water sufficiently to please tilapia, which prefer a temperature range of 68° to 86°F (Bardach et al., 1972). When he tried trout, the water was heated to intolerably high levels during the summer. While trout can withstand temperatures as high as 70° F for short periods of time, optimal culture temperature lies between 45° and 55° F.[1] Conceivably, a two species grow-out cycle would work, trout in the cold months, tilapia in the warm ones. But the trout "fingerlings" would have to be nearly full grown, and their expense might impair profitability. Hybrid striped bass may be a better bet for year-round culture; they grow under conditions cooler than tilapia and warmer than trout, with an optimal temperature range of 55° to 75° F (Stickney, 1986). Another approach suggested by the researcher was that it may be possible to raise tilapia in an integrated greenhouse hydroponics system using waste heat from a public utility in the winter months.

Using waste heat from factories for grow-out purposes is not a new idea. One such facility is in operation in Pennsylvania, although it is said to be economically marginal. There is discussion of linking recirculation aquaculture with factory waste heat in New York City. A test project, involving the culture of hybrid striped bass, has been initiated in a bakery basement in Brooklyn. Early reports of the biological feasibility of this project are positive.

A test project raising Tilapia in a water reuse system, was conducted in an Elizabeth, New Jersery warehouse. The project was a biological and technical success. Fish were raised to a weight of one pound. Mortality was low. The project did not include an economic analysis. However, the authors state that "it is uncertain whether the marketing effort required would bring sufficient returns to make the system commercially viable."[2] They suggest that it may be desireable to raise a species that commands a higher price in the marketplace.

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[1]Davis, p. 12.

[2]New Jersey Department of Agriculture, p. 7.

SECTION FOUR - MARKETING STRATEGIES

The essential factors that shape each aquaculture operation are the natural resources that the grow-out site is endowed with (with equal emphasis on quantity and quality), the geographical location of the site, the amount of capital available to management,[1] and, of course, the management abilities of the operator. These factors help to explain the tremendous variation in the fish farming businesses in the Northeast. The variabilty also indicates an array of potentially viable production and market niches. A brief description of the market options available to freshwater aquaculturists follows.

4.1 MARKETING OPTIONS

Nearly 70% of the sales reported by survey respondents are of fish for stocking. These fish, ranging in size from two to eighteen inches and in price, respectively, from $45 to $1200 per hundred, are sold to private pond owners, sportsmen's clubs, and other hatcheries, both private and governmental. Fish farmers tend to prefer the clubs and other hatcheries as customers. These groups are experienced; they know what they are doing. Many private pond owners, by comparison, are inept. Their ponds simply do not have the right conditions to support fish. Disappointed when the trout turn belly up from lack of oxygen or excessive temperatures, they tend to place the blame for their own failure on the aquaculturist whom they bought the fish from.

The stocking market is rather tight. There is a lot of competition. Many growers reported having to travel great distances to sell their fish. Growers who deliver fish for stocking across state lines are frequently required by the importing states to have their fish certified as disease free. If the resulting tests indicate the presence of one of the eight diseases generally tested for, the grower is prohibited from selling live fish in that state for the following three years. Clearly, this puts a tremendous strain on any grower who relies on out-of-state sales. Disease certification is discussed in greater detail in Chapter Six.

The remaining 30% of the fish produced by aquaculturists in the Mid-Atlantic region winds up on the consumers' tables. Large volume producers of food trout (to date no other freshwater species have been successfully reared in large volumes in the Northeast) tend to market through established fresh and frozen fish wholesale and retail channels. These producers are too large to engage in direct sales. As a result these producers are in direct competition with the large trout producers in Idaho. Delivery of a fresher product generally allows them to charge a slightly higher price than their western competitors.

Smaller producers have the option of selling directly to restaurants and/or consumers. Generally, these fish farmers cannot afford to compete with larger producers in the wholesale and retail markets. They simply cannot bring in fish at aprice that justifies sales on this level. Direct sales enable these producers to capture the value added that would otherwise accrue to the middlemen who move the product through the distribution chain. Small producers can charge more than the middleman and still secure sales by providing a fresher product and by performing more services.

Many commercial aquaculturists establish pay-to-fish ponds on their fish farms. They stock these ponds with food-sized fish (and sometimes with "trophy" fish) and then charge anglers for the pleasure of catching them. Usually a per angler entry-fee is collected; the fish that the anglers catch are sold by the inch or by the pound. Catch and release fishing is generally prohibited.

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[1]In many cases ingenuity and practical skills can be substituted for capital, up to a point.

Growers employ a range of strategies in servicing these markets. Larger producers service a broad sales spectrum. This helps to assure optimum sales levels. Smaller growers may choose to specialize. Focusing on one market allows them to develop strong sales relationships with repeat customers. With effort they can gain a reputation for service, quality, and consistency. Still smaller operators can "distribute" mature fish. Buying in fish of marketable size from larger hatcheries, these aquaculturists strive for high turnover through direct sales. A further strategy available to aquaculturists is the establishment of correlary enterprises. This could range from the provision of picnic food to fee-fishing anglers to the sale of composted solid wastes captured in recirculation system filters for houseplant fertilizer. Such opportunities should, of course, be examined carefully. Ideally, they should generate additional revenues without placing undue demands on management. The details of these market positioning strategies are best illustrated by the interviews that were conducted with several of the survey respondents.

4.2 FISH DISTRIBUTOR OPERATION

The first fish farmer to be interviewed runs a small but promising business. He operates a single raceway near a large metropolitan area. Essentially, the operator is a fish distributor. He purchases 500 lb of market-sized rainbow trout every three weeks from a large, privately owned hatchery. He holds the fish until the day of sale to a growing list of local restaurants. He is competing directly with the mass producers of trout in Idaho who market their fish through standard distribution channels. He charges slightly higher prices than the local distributors charge for Idaho fish, but he offers a fish of arguably higher quality and he provides the service of same-day delivery any day of the week. The Idaho fish can be 5 days old by the time it reaches restaurants in the Northeast. Buying the fish the same day as slaughtered provides the restauranteur with a fresher product that can be kept on ice for a longer period. Flexible delivery schedules also result in lower losses to spoilage. Restaurant sales of trout entrees are relatively flat, representing approximately 5% of fish meals sold. Hence, given restauranteurs' insistence on a fresh, rather than frozen or vacuum packed, product, the sale of freshly slaughtered trout on a flexible same day delivery schedule is an excellent marketing strategy.

The "distributor" set-up offers other advantages to the manager as well. High levels of stock turnover allow more fish to pass through a small facility. The distribution approach enables the manager to capitalize on the resources of a low-flow site in a geographically strategic area. Holding the fish for a relatively short period of time reduces the risk of loss to disease. Essentially, this risk is passed on to the supplier of the nearly market-sized fish who manages too large an operation to profitably engage in this form of marketing. Distributing trout represents a viable market niche. Providing the services described above enables competition with Idaho. High labor costs and the necessity for delivery flexibility and personal customer relationships keep the larger regional producers out of this market.

4.3 FULL-SPECTRUM MARKETING

A second type of aquaculture business represents the other end of the spectrum. This business is large and is frequently owned by investors and managed by professionals. The business employs full-time staff and produces 200,000 to 1,000,000 pounds of fish per year. The water for the facility is generally supplied by a small lake or a large aquifer. High volume water flow allows high stocking densities.

The largest Middle Atlantic trout producers compete directly with the producers in Idaho. As much as three quarters of their output may be sold to wholesalers. Again, freshness and same day delivery allow Mid-Atlantic producers to charge a slightly higher price than their Idaho counterparts. This premium, combined with much lower transportation costs, makes competition with the gigantic Idaho producers possible. Yet, price remains a critical factor. Profit margins are low. Income is secured by high sales volumes.

Such a high volume orientation frequently necessitates the use of resource-boosting technologies. Oxygen injectors in the raceways raise oxygen to saturated levels. Eviscerating machines are sometimes used for fish processing. Scale also has its problems. Disease is a constant hazard, and nearly a third of the fish can be lost to predatory birds annually.

Sales for the large regional producers may be divided between restaurants, wholesalers, live stocking, and fee-fishing. Multiple outlets help to assure adequate sales levels. When demand is robust, the highest paying market can be targeted. Competition is relatively high in the first three fields. Because the fee fishing ponds are on-site, they generally draw customers only from the local area. The geographic dispersion forced upon larger aquaculture operations by the paucity of adequate water sites tends to reduce the intensity of competition. They can market fresh fish through local channels without much direct competition. These businesses appear to be rather profitable. Allowing for as much as 35% loss to disease and depredation, revenues resulting from the sale of the surviving stock are sufficient to more than cover operating and fixed costs.

4.4 MEDIUM SCALE PRODUCTION

A number of respondents produce between 30,000 and 200,000 pounds of trout annually. They sell their fish to retailers, wholesalers, and directly to pond owners, other hatcheries, and pay-to-fish customers. As much as half of all sales may be made through fee-fishing. At this level of production, growers report that Idaho competition prohibits sales to wholesale and retail markets; curiously, they report that competition precludes the restaurant market as well.

One owner of such an operation says his business is profitable. He plans to nearly double production by 1995. Another aquaculturist interviewed raises 35,000 pounds of trout per year. He sells these fish primarily for stocking purposes. Prices vary from $4 to $40 per pound depending on the size of the fish. The market is very tight. Lacking disease-free status compounds his marketing difficulties. Frequently, great distances must be travelled to sell a load of fish. The manager has attempted to sell to local restaurants and supermarkets. He found this market to be totally flat, even in a relatively affluent area.

4.5 SMALL SCALE PRODUCTION

Many aquaculturists produce less than 30,000 lb annually. One manager of such an operation attempted to sell fish directly to restaurants and super-markets. His efforts ended in frustration. Direct sales are labor intensive, and he could not charge a high enough price to justify the hassle or the expense. Living in an area where the fresh ocean catch is plentiful, demand for trout was slack. Even after recent scares about the quality of the ocean catch, demand did not pick up.

Another fish farmer is just getting underway. He has found a good water source and has constructed his facility, which consists of four raceways, a hatchery, and a processing facility. He produced 25,000 pounds of trout last year. For the time being he is dependent on direct sales to customers for his income. He wants to build a reputation for dependable supply. Hence, he is waiting to approach retailers and restaurantuers until he can grow sufficient amounts of fish to satisfy their demand on a regular basis. Hopefully, this strategy will generate long-term repeat customers. He hopes to expand his facility to produce 100,000 pounds annually by 1995.

SECTION FIVE - FINANCIAL FEASIBILTY ANALYSIS

5.1 FISH DISTRIBUTOR OPERATION

The first set of figures below refers to the fish distributor operation described in Chapter 4. This facility is located on a small piece of leased land on the outskirts of a metropolitan area. A spring-fed stream supplies the water to a single outdoor raceway. A pump lifts the water 5 feet through a pipe from the stream to the raceway. The pump is fitted with a flow switch that activates the owner's telephone beeper in the event of mechanical failure. The delivery outlet of the pipe is raised above the raceway's water level. The action of the spilling water increases the supply of dissolved oxygen in the raceway. The fish congregate in the upstream half of the raceway where water quality is best. They are fed by demand feeders. Boards stretched across the raceway provide shade and shelter from predators. Waste solids settle out in the "downstream" end of the raceway. These are collected periodically and spread on the fields of a nearby ornamental plant nursery.

The business is operated on a part-time basis. Current sales volume is just over 180 lb per week, processed weight (9,480 lb per year). The owner plans to increase his scale of operation. He will be selling 500 lb a week, processed weight, and working full time by 1991. He figures that this level of business will bring him a satisfactory income. The business will still be small enough for him to manage it by himself. By so doing, he can keep an eye on product quality and maintain personal contacts with his customers. An income analysis of this business follows. The data was reported directly by the manager as part of the interview process.

Table 20. Investment for Fish Distributor Operation

Item	Expense
Raceway Construction	$992.00
Lumber	228.00
Pipes	110.00
Pumps	675.00
Rental Equipment	227.00
Total	$2232.00

Table 21. Income Analysis of a Part-Time Fish Distribution Operation

Level of production: 11,700 lb per year (live weight)

Prices charged:

Dressed:
40% of live weight sales = 4680 lb;
less 13% weight loss due to processing = 4072 lb @ $2.60/lb

Boned:
60% of live weight sales = 7020 lb;
less 23% weight loss due to processing = 5405 lb @ $3.60/lb
Weighted average price per processed pound:
9477 lb @ $3.20/lb

Revenue:
4072 lb @ $2.60 = $10,587.20
5405 lb @ $3.60 = 19,458.00

Total revenue: $30,045.20

Table 21 Continued:

Variable costs:			
Feed	$ 360.00		
Fish[1]	2,1060.00		
Screens	33.00		
Supplies	22.00		
Packaging	48.00		
Delivery fuel	225.00		
Vehicle maintainence	325.00		
Total variable costs		$22,073.00	
Fixed costs:			
Insurance	$ 320.00		
Utilities	900.00		
Telephone	300.00		
Beeper	300.00		
Lease	300.00		
Facility depreciation[2]	223.20		
Vehicle Depreciation	400.00		
Total fixed costs:		2,743.20	
Total costs:			$24,816.20
Net return to operator's labor, management, and equity:			$5229.00
Charge for equity capital (5% real rate):[3]			$111.60
Return to operator's labor and management:			$5,117.40
Hourly return to operator's labor and management:[4]			$4.92/hour
Breakeven prices[5] for part-time operation:			
		Weighted average:	$2.62/lb
		Dressed:	$2.13
		Boned:	$2.95

[1]Fish are purchased at $1.80/lb. There is no delivery charge for orders of 500 lb and over.
[2]Straight-line depreciation, assuming a useful facility life of ten years with zero salvage value.
[3]The real rate is the nominal rate (12% in this case) less the inflation rate. The real rate reflects the long-term average rate of return that an aquaculturist could expect to earn on investments with comparable risks to aquaculture in an economy with little or no inflation.
[4]52 twenty hour weeks = 1040 hr; $5,117.40 ÷ 1040 hr = $4.92./hr.
[5]Breakeven price is the price at which current output can be sold to gain sufficient revenues to cover total operating costs (x = total costs ÷ number of processed pounds produced).

Table 21 Continued:

Breakeven quantity[1] of sales at current price levels:

Dressed:	3,102 lb
Boned:	4,653
Total:	7,755 lb

Return on capital investment for part-time operation:	
Net return to operator's labor, management, and equity:	$ 5,229.00
Opportunity cost for operator's labor and management:[2]	-10,000.00
Debt interest:	0.00
Return to all capital:	$-4,771.00
Rate of return to all capital:	-214%

The net return to operator's labor, management, and equity for the part-time fish distribution business is positive. However, the owner is not realizing a significant portion of his total income at this level of output. Clearly, he could do better in another line of work. However, this is a development phase for the business. As demonstrated by the projections inTable 23, future expansion will yield better results.

Table 22. Projected Income Analysis of a Full-Time Fish Distributor Operation

No additional investment is required. It is assumed that both prices and the distribution of sales will remain the same.

Production level: 32,100 lb per year (live weight)
26,000 lb per year (processed weight)

Prices charged:

Dressed:

40% of live weight sales = 12,840 lb;
less 13% weight loss due to processing = 11,170 @ $3.20

Boned:

60% of live weight sales = 19,260 lb;
less 23% weight loss due to processing = 14,830 @ $3.60

Weighted average price per processed pound: 26,000 lb @ $3.20

Revenue:

(11,170)(2.60) = $29,042.00
(14,830)(3.60) = 53,388.00

Total Revenue: $82,430.00

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[1]Breakeven quantity is a measure of the amount of output required to cover operating costs at current prices (y = total costs ÷ weighted average price per processed pound).
[2]Opportunity cost is a measure of the value of the operator's labor in other pursuits. This particular operator has a college education and 8 years of work experience. His labor is worth at least $20,000. Considering the requisite management and marketing skills for successful operation, this seems a fair minimum value for the labor and management time of most aquaculture enterprise operators.

Variable costs:		
Feed	$ 1,100.00	
Fish[1]	52,965.00	
Sreens	100.00	
Supplies	50.00	
Packaging	150.00	
Delivery fuel	400.00	
Vehicle maintainence	400.00	
Total variable costs		$ 55,165.00
Fixed costs:		
Insurance	1,000.00	
Utilities	1,500.00	
Telephone	450.00	
Beeper	300.00	
Lease	300.00	
Facility depreciation	232.20	
Vehicle depreciation	400.00	
Total fixed costs:		4,182.20
Total costs:		$59,347.20
Net return to operator's labor, management, and equity:		$23,082.80
Charge for equity capital (5% real rate):		$111.60
Return to operator's labor and management:		$22,971.20
Hourly return to operator's labor and management: (50 hours per week, 52 weeks per year):		$8.84/hour
Breakeven prices for full-time operation:		
	Weighted average:	$2.28/lb
	Dressed:	$1.85
	Boned:	$2.57
Breakeven quantity of sales at current price levels:		
	Dressed:	7,418 lb
	Boned:	11,128
	Total:	18,546 lb
Return on capital investment for full-time operation:		
Net return to operator's labor, management, and equity:		$23,082.80
Opportunity cost for operator's labor and management:		20,000.00
Debt interest:		0.00
Return to all capital:		$ 3,082.80
Rate of return to all capital:		138%

[1]For purchases of 2000 lb or more the price of fish drops to $1.65/ lb.

Operating at full-scale, this enterprise is profitable. Prices currently charged are well above breakeven level. Returns to the operator's labor and management exceed opportunity costs. The initial investment is easily paid off in one year of full-time operation. The owner reports that the percentage of boned (vs. dressed) fish sales is increasing. This will further raise revenues.

5.2 SMALL SCALE RACEWAY OPERATION

The second business for which financial figures were obtained is a traditional grow-out hatchery. The owner-operator maintains his own brood stock, and hence, raises his fish from the eggs which he collects and fertilizes. His raceways and hatchery are stream fed. He has a processing facility and sales office on site. Sales are divided between direct sales to consumers (2%), supermarkets (13%), and restaurants (85%). The owner is just getting started. First year production will be 15,000 pounds. In the second year output will be more than doubled to 40,000 pounds. This level of production will require the hiring of a marketing assistant. If the business is successful at this level, the owner may expand his facility further.

Table 23. Investment for a Small-Scale Raceway Operation

Item	Expense
Purchase of land	$20,000.00
Building materials	45,000.00
Concrete (for raceways)	10,000.00
Reinforcing steel	1,000.00
Lumber	1,000.00
Pipes	1,800.00
Pumps	3,500.00
Labor	72,000.00
Miscellaneous	5,000.00
Total	$159,300.00

Table 24. Income Analysis for a Reduced Output Small-Scale Raceway

First year production level: 15,000 pounds (live weight)
12,314 pounds (processed weight)

Form and price of fish sold:

Whole, ungutted (no weight loss; 2% of sales) @ $3.00/lb
Head-off, gutted (20% weight loss; 85% of sales) @ $3.75/lb
Head-on, gill-in (7% weight loss; 13% of sales) @ $3.50/lb
Weighted average price: $3.70/lb

(0.02)(3.00)(15,000) =	$ 900.00	
(0.80)(0.85)(3.75)(15,000) =	38,250.00	
(0.93)(0.13)(3.50)(15,000) =	6,347.25	
Total revenue:		$45,497.25

Table 24 continued:

Variable costs:			
Feed	$ 4,800.00		
Supplies	1,500.00		
Packaging	200.00		
Ice	100.00		
Screens	500.00		
Fuel	1,500.00		
Truck maintainence	1,200.00		
Facility maintainence	800.00		
Total variable costs:		$10,600.00	
Fixed costs:			
Insurance	$ 1,000.00		
Utilities	240.00		
Telephone	350.00		
Property taxes	1,100.00		
Interest	4,800.00		
Facility depreciation[1]	11,430.00		
Equipment depreciation	1,000.00		
Total fixed costs:		19,920.00	
Total costs:			$30,520.00
Net return to operator's labor, management, and equity:			$14,977.25
Charge for equity capital (5% real rate):			$7,965.00
Net return to operator's labor and mangment:			$7,012.25
Hourly return to operator's labor and management (40 hours per week; 52 weeks per year):			$3.37/hour
Breakeven prices for part-time operation (based on processed weight):			
		Weighted average:	$2.48/lb
		Direct:	$2.01
		Restaurants:	$2.51
		Retail:	$2.35
Breakeven quantity of sales at current price levels:			
		Direct:	165 lb
		Restaurants:	7,012
		Retail:	1,072
		Total:	8,249 lb

[1]Straight-line depreciation, assuming an investment life of 10 years with a salvage value of $45,000

Table 24 continued:	
Return on capital investment for full-time operation:	
Net return to operator's labor, management, and equity:	$14,977.25
Opportunity cost for operator's labor and management:[1]	-20,000.00
Debt interest:	+ 4,800.00
Return to all capital:	-$ 222.75
Rate of return to all capital:	-.1%

This business requires considerably more investment than the fish distribution operation. At partial output net returns to the operator's labor and management are greatly exceeded by his opportunity cost. Once again, this is a building phase for the business. Full scale output will result in higher returns if the operator can survive the low returns generated in his first two years of operation

Table 25. Income Analysis for a Full Output Small-Scale Raceway

Second year production level: 40,000 lb (live weight)			
28,364 lb (processed weight)			
No additional investment will be required to expand production.			
Revenue:			
(0.02)(3.00)(40,000) =	$ 2,400		
(0.80)(0.85)(3.75)(40,000) =	102,000		
(0.93)(0.13)(3.50)(40,000) =	16,926		
Total revenue:			$121,326.00
Variable costs:			
Labor	$17,000.00		
Feed	12,000.00		
Supplies	1,500.00		
Packaging	540.00		
Screens	800.00		
Ice	350.00		
Fuel	2,500.00		
Truck maintainence	1,500.00		
Facility maintainence	1,000.00		
Total variable costs:		$37,190.00	
Fixed costs:			
Insurance	2,000.00		
Utilities	350.00		
Telephone	400.00		
Property taxes	1,100.00		
Interest	4,800.00		
Facility depreciation	11,430.00		
Depreciation	1,000.00		
Total fixed costs:		21,080.00	
Total costs:			$ 58,270.00
Net return to operator's labor, management, and equity:			$63,056.00

[1] $20,000 is also a fair minimum value of this operator's labor.

Table 25 Cont.:

Charge for equity capital (5% real rate):		$7,965.00
Net return to operator's labor and management:		$55,091.00
Hourly return to operator's labor and managment (50 hours per week; 52 weeks per year):		$21.19/hour
Breakeven prices for part-time operation (based on processed weight):		
	Weighted average:	$2.05/lb
	Direct:	$1.66
	Restaurants:	$2.08
	Retail:	$1.94
Breakeven quantity of sales at current price levels:		
	Direct:	315 lb
	Restaurants:	13,387
	Retail:	2,047
	Total:	15,749 lb
Return on capital investment for full-time operation:		
Net return to operator's labor, management, and equity:		$63,056.00
Opportunity cost for operator's labor and management:		-20,000.00
Debt interest:		+ 4,800.00
Return to all capital:		$ 47,856.00
Rate of return to all capital:		30%

At full output this business is quite profitable. Income results in a high rate of return to capital. Breakeven prices are 55.4% of prices currently charged. Returns to the operator's labor and managment are more than twice his opportunity costs.

5.3 RECIRCULATION SYSTEMS

It was not possible to obtain financial figures for an enterprise using recirculation technology for this study. However, there is one recent report on the subject. The Bitz family, who own and operate Plainville Turkey Farm, Inc. of Plainville, New York, received a grant from the New York State Department of Agriculture and Markets to examine the feasibility of trout production using a recirculation system designed by researchers at Cornell University in 1987(Bitz, 1988; Timmons et al., 1987).

The Bitzs constructed two Cornell systems, each consisting of two grow-out tanks and one settling tank, which they operated over a 10 month period. The two systems have a combined carrying capacity of 4 tonnes (8,800 lb) of live fish. While conducting this pilot project, the Bitzs experienced some problems; they lost a quarter of their stock in two fish kills. Evidently, they regarded this as a one-time mishap, for in the cost analysis of the project a less catastrophic fish mortality of 6% is projected. Culturists consider mortality levels of 10% and below to be routine. Such losses are planned and compensated for by simply purchasing a proportionately greater number of fingerlings at the outset of the culture cycle.

The pilot project cost analysis is based on the two system (4 tank) facility. Annual production is pegged at 8,500 lb, 96.5% of carrying capacity in a "once through" grow-out. The Bitz's efforts resulted in a total live weight cost per pound of fish raised of $3.75.

This is 18¢/lb greater than the per pound cost projected by the Cornell team for a once through grow-out.[1] Experienced operators would manage such a system with fish of a variety of sizes and ages. This would result in greater total output as well as the ability to stagger market delivery. Pilot projects are not generally of sufficient scale or duration to allow thorough analysis of the costs and complexities of advanced management practices.

Table 26. Cost Analysis of Plainville Turkey Water-Reuse Project

Total live weight cost:		$3.75/lb
Yield, head-off (75%): (3.75 / 0.75)	$5.00/lb	
Processing & packaging labor:	.19	
Packaging materials:	.08	
Marketing costs, overhead, profit:	.50*	
Wholesale cost:		$5.77/lb
Yield, filleted (50%) (3.75 / 0.50)	$7.50/lb	
Processing & packaging:	.77	
Wholesale cost of fillets:		$8.27/lb

* These figures are taken directly from the Bitz report. No indication is given as to the composition this particular sum.

The Bitzs determined that the Cornell system was not cost efficient. Given a once through management system, this would be true. Using more advanced management stocking manipulations,[2] Timmons et al. estimate a total live weight cost per pound of $2.22. This results in a head-off price of $2.96 and a wholesale price of $3.73, based on the Bitz figures. These prices are within the range of feasibility.

Further research by the Cornell team has resulted in cost reducing innovations.[3] However, these developments are yet to be tested by a private commercial enterprise. As suggested in Chapter Three, recirculation remains a risky technology. While the rearing of fish may be technically feasible, it appears that operators cannot be reasonably assured, given the technology currently available, that the system will deliver fish of marketable size at a competitive cost.

With the exception of recirculation systems, it appears that aquaculture, as practiced in the Mid-Atlantic states, can be quite profitable. The reader should bear in mind that the above analyses are case studies. The circumstances which shape an individual aquaculture enterprise are highly variable. These businesses represent the possibility of profits, but it cannot be inferred from their success that an aquaculture venture is in all cases a sure thing or that the industry as a whole necessarily enjoys this fortune.

[1]Timmons et al., p. 10.4.20, column A.
[2]Refer to explanation of recirculation system management complexities on page 18.
[3]Personal communication, Professor Mike Timmons.

SECTION SIX - POTENTIAL PROBLEMS

6.1 DISEASE CERTIFICATION

Many fish farmers who sell live fish for stocking and/or fingerlings for food fish grow-out submit to annual tests for disease. These tests are required by the states into which fish are imported. Currently, the Department of Microbiology at the Orono campus of the University of Maine has the only diagnostic laboratory in the Northeast licensed to perform disease certification inspections. Consequently, a significant portion of the $875 per lot testing fee pays for the travel expenses of the inspection team. Each "lot" is a sample of 60 fish, taken from a discrete raceway, pool, etc. on the facility. An individual firm may have only one or as many as five to ten separate stocks of fish. Each separate population must be tested. The sampled fish are examined for the presense of as amny as 8 disease organisms. Different states have different requirements. Certifications are valid for one year.

If any disease is detected in any lot, the entire facility is labelled as carrying the disease. Disease status is an albatross. It cannot be shed until at least three years have passed and more testing, yielding favorable results, has been conducted. One respondent has a strategy for dealing with this problem. He plans to construct a second, entirely separate facility, and thus spread his risk. If one facility becomes diseased, he can still maintain disease-free status at the other. Disease-free status is coveted. Other operators, seeking disease free stock, beat a path to a disease-free propagator's door. This eases the logistics of marketing for the disease-free stocker considerably, and his fish command a higher price.

There is no way around disease certification for interstate purveyors of live fish. Receiving states are rightly concerned with preventing the spread of disease. But, while the intent is good, the mechanism of certification is burdensome. To ease the process, and render it less expensive, regional aquaculturists are calling for the establishment and licensing of more regional diagnostic laboratories. At least one proposal has been submitted, arranging for the involvement of professionals at Cornell University's College of Veterinary Medicine in the certification process.

6.2 WASTE WATER REGULATIONS

Governmental waste water control measures are another critical issue affecting aquaculture in the Northeast. Federal and state governments are concerned with the quality of public waters. Hence, the environmental agencies empowered by these governments require any "industrial" business that discharges effluents into public waters to comply with pollution control standards. Currently, the waste discharges of aquaculture enterprises are designated as industrial.

The federal government regulates the discharges of effluents into navigable waters under the Federal Water Pollution Control Act, as amended by the Clean Water Act (33 USC sections 1311 et seq.) and National Environmental Policy Act of 1969 (42 USC sections 4321 et seq.). Unless specifically excepted by the statutes, permits must be obtained from the Administrator of the Environmental Protection Agency.[1] Facilities that annually produce above a threshold amount of fish must meet state and federal industrial effluent standards, rather than the more lenient agricultural effluent standards. The Pennsylvania Department of Environmental Resources has established this threshold at 20,000 pounds of fish produced per year or 2,000 pounds of feed fed per month. Businesses of this size must obtain State Pollutant Discharge Elimination System (or

[1]New York Sea Grant Institute, p. 30.

"speedies") permits. Smaller aquaculture enterprises that produce fish at below threshold levels and that are located in environmentally sensitive areas may also be required to obtain permits. In New Jersey, where only one "New Jersey Pollutant Discharge Elimination System" permit has been issued to date,[1] threshold levels are determined on a case by case basis.[2] Compliance is expensive; operators must perform tests on their effluent to determine levels of biological oxygen demand, phosphorus, settleable and suspended solids, bacteria, and nitrates. The frequency with which these tests must be performed (monthly, weekly, or daily) depends on the amount of fish an individual firm produces and upon the nature of the waters the effluent enters. Aquaculture enterprises located near wildlife preserves and other environmentally sensitive areas are likely to be monitored more closely. Three survey respondents located near New York State Parks reported considerable difficulty in obtaining permits.

In New York only 20 speedies permits have been issued to date, although the state has 51 private commercial freshwater hatcheries[3] and 13 state operated hatcheries.[4] According to survey participants, the New York State Department of Environmental Conservation (D.E.C.) is most concerned about the effluent of aquaculture enterprises situated near state parks and/or wild streams. Aquaculturists located in less sensitive areas are apparently not pursued by D.E.C. regulators with the same vigor. The story is much the same, reportedly, with the Pennsylvania State Department of Environmental Resources. Survey respondents worry that as public concern for the quality of the water supply increases, and as the number of aquaculture businesses grows, agency attention to regulation is likely to increase. Complying with speedies regulations is likely to boost operating costs significantly. These costs include the testing itself and the design and installation of effluent cleansing systems to better enable compliance.

Speedies permits present a problem for aquaculture under its current industrial designation. The New York and Pennsylvania state aquaculture associations are lobbying their respective state governments for agricultural status. Aquacultural fish wastes are a biological product, generated by a process akin to traditional forms of agriculture. Why, the aquaculture associations reason, should they be treated differently? Farmers manipulate their environments as a matter of course. Such practices as the spreading of manure are routine. Under agricultural designation, waste removal and disposal technologies that treat fish manure as a resource, rather than a hazard, should be more acceptable to regulating agencies. Technologies designed for the recapture and recycling of fish manure would be easier to design and less expensive to implement than the systems required to manage "industrial" wastes.

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[1]Currently, there is only one commercial freshwater aquaculture business in the state.
[2]Regualtions implementing the New Jersey Water Pollution Control Act (N.J.S.A 58:10 A) define aquaculture as a concentrated animal feeding operation. Aquaculture is therefore subject to these regulations, a statement of which can be obtained from the New Jersey Department of Environmental Protection.
[3]This is the count from the New York State Department of Environmental Conservation's list of private and commercial hatcheries in the state. The list is available by request from the N.Y.S.D.E.C.
[4]New York Sea Grant Institute, p. 11.

6.3 LEGISLATION CONFLICTS

Across the nation, commercial fish farmers are complaining that many business activites essential to their financial well-being are confounded and curtailed by outdated legislation, originally passed to regulate other activities. Primarily, these laws were enacted to protect wild fisheries. Many of them prohibit the transport of certain fish species across state lines (USDA, 1989), while others prevent the culture of "exotic" species.

The primary federal legislation of concern is the Lacy Act. Originally enacted in 1948, the Lacy Act is an outgrowth of earlier legislation passed in 1909. This first Act[1] outlawed the importation into the United States of any birds and animals deemed injurious to the interests of agriculture or horticulture by the Secretary of Agriculture. Foreign wild birds and animals could only be imported under permit. The Lacey Act transfers the authority granted in the earlier act to the Secretary of the Interior. In addition this Act forbids the delivery or receipt of any wild mammal, bird, amphibian, reptile, mollusk, or crustacean, or any part, egg, or offspring thereof that has been "imported from any country, or captured, taken, purchased, sold, or possessed contrary to any Act of Congress, or the law of any State, Territory, Possession, or foreign country."[2] The Lacey Act was amended in 1981.[3] The new wording specifically includes fish among the other forms of wildlife covered by the Act. The amendment further bars the export from the U.S. and transport within the U.S. of any of the affected fish and wildlife. The Lacy Act has been invoked to proscribe "fish or eggs of the family Clariidae (walking catfish) and the live or dead fish or eggs of the fish family Salmonidae (salmon)."[4] The Act was recently enforced in Georgia. This case illustrates the issues involved.

"The President of the U.S. Trout Growers Association is being tried (in Georgia) for violation of the Lacey Act. The basic conflict is that the Georgia laws tend to look on trout, both farm-raised and wild, as resources owned by the state. This trial holds a great deal of importance for the aquaculture industry for two reasons . First, many states have similar laws governing the importation of certain fish species. Second, Georgia State law holds that fish farmers must obtain a license from the State fish and wildlife department to grow fish. Most aquaculturists would like to be seen as no different than other agricultural businesses."[5]

Clearly, a sensible line has to be drawn between the legitimate concerns of state environmental agencies and the right of aquaculturists to pursue profitable production strategies.

In response to the lobbying efforts of New York aquaculturists, state legislators have proposed the "New York Aquaculture Development Act."[6] If enacted this bill will establish the N.Y.S. Department of Agriculture and Markets as the lead agency in promoting the development of aquaculture in New York State. It will designate aquaculture as an agricultural activity, while allowing the Department of Agriculture and Markets to draft regulations concerning the sale and transportation of aquaculture products, including

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[1]Act March 4, 1909, Chapter 321, § 241, the 60th Cingress, Session II.

[2]U.S. Statutes at Large, 1948, Vol. 68, part 1, § 43, p. 687.

[3]Act November 16, 1981, P. L. 97-79, § 1, 95 Stat. 1073.

[4]Aspen Research and Information Center, p. 1.

[5]U.S.D.A., E.R.S., 1989, p. 12.

[6]Bill 10803, introduced in assembly of the State of New York legislature on April 14th, 1988. The bill has so far failed to pass into law.

those imported from other states. Unfortunately, agricultural designation is limited to enterprises of "not less than ten acres". It is possible for aquaculture businesses of significant scale to occupy less than ten acres. This minimum acreage stipulation seems rather arbitrary and should be done away with.

The bill establishes several committees for the purpose of easing and articulating the development of aquaculture in New York State. The development of aquaculture will proceed more smoothly under the direction of a lead agency. State departments of agriculture in coordination with the USDA, which has aldready taken over the direction of aquaculture from the Department of Commerce, can directly and effectively support the emerging industry, while providing a forum in which the concerns of other agencies may be addressed.

6.4 FOOD SAFETY

As aquacultural production increases across the nation, new issues and concerns are likely to arise. One such issue is that of food quality. Presently, consumers are tremendously concerned about the safety of the wild fish catch. Trace levels of toxic pollutants are turning up in the fish we eat. For years we have dumped wastes in the ocean and other waterways. Toxins in fish may be an inevitable consequence. In regard to food safety aquaculture has a potential advantage over the rest of the fish industry; the growth environment of the fish is more controllable. However, some aquacultural practices may erode this advantage. As aquaculture becomes more prevalent and consumers learn more about it, they may grow wary of the use of growth hormones, antibiotics, and certain disease and parasite fighting chemicals. Fish raised by cage culture in pollutable waterways are also likely to raise questions of food safety. Whether or not they are well founded, such consumer concerns will be manifested in the marketplace. Aquaculturists should hold themselves to a higher standard.

It is to the aquaculture industry's advantage to set its products apart from the ocean catch. Currently, all fish are displayed together in supermarket fish cases. Little indication is given of the varying origins of different fish. Customers used to asking for the catch of the day should be impressed with the consistent availability of aquacultural products. Consumers concerned with the safety of eating fish should be convinced of the purity of farm raised fish. For regional producers this is more of a long term concern. An informal survey of a dozen fresh fish buyers for major supermaket chains across the Mid-Atlantic states indicated that regional aquaculture products have very little presence, let alone identity, in regional stores. Farmed shrimp and catfish and imported farmed salmon are frequently stocked, but they are seldom identified as aquacultural products. These supermarket fish buyers report that trout is not a high demand, high turnover product. The trout that they do carry is generally purchased from Idaho producers. Other species produced locally are not available in sufficient supply for retail marketing.

Currently, regional aquaculture associations and other proponents of fish farming are discussing the formation of a national aquaculture association. The primary objective of such an association would be to work with federal and state governments in the resolution of inter-regional legislative conflicts and the removal of other obstacles to the conduct of free enterprise. This body could assume a further role, that of a generic marketing board. A central body is needed to promote aquacultural products. Individual producers may be too small and/or too far away from their ultimate market to secure effective promotion. A generic marketing board could present the general benefits of aquaculture products to the public. Separate boards could be established for species that are produced in significant quantities.

A correlary to the generic promotion of aquaculture products is the idea of product branding. This is another means of distinguishing the product and setting it apart from the general fare. Branding does not always require a vastly different product. A reputation for consistent quality together with some form of distinctive packaging or labelling is sufficient. Successful branding can result in increased sales. If the product is regarded as a specialty, higher prices can be charged. This strategy can be effective in the restaurant trade as well as retail markets.

SUMMARY AND CONCLUSIONS

Three study objectives are identified in Chapter One. The first is to provide a descriptive analysis of freshwater finfish aquaculture in the Mid-Atlantic states. This analysis is based on information gathered through a mailed survey and in-person interviews. Chapter Two presents the survey data solicited from regional aquaculturists; Chapter Three describes the range of grow-out technologies and their use by Mid-Atlantic culturists; Chapter Four illustrates the marketing options available to producers at various scales; Chapter Five examines the earning potential of specific enterprises; and Chapter Six gives light to several issues which affect the aquaculture industry. A broad picture of regional aquaculture has been drawn, based on the information supplied by the survey respondents. Only 46% of the 188 individuals identified as potential aquaculturists were reached by the survey. However, the majority of large producers in the region were contacted. Further efforts to canvas the entire list of regional producers may reveal innovative production and marketing practices and information regarding issues and concerns not considered in this report.

The second objective of the study is to estimate the profitability of a variety of freshwater finfish aquaculture enterprises. This is accomplished in Chapter Five. The financial analyses presented are essentially case studies. They describe individual enterprises involved in a singular set of circumstances. Given the tremendous variety of factors that shape an individual enterprise, it is clear that the results achieved by these businesses cannot be extended to the regional industry as a whole. A more detailed study of Mid-Atlantic aquacultural enterprises, similar to the farm business summaries published for other agricultural industries, is required to gauge the economics of the regional industry as a whole. In-depth management and marketing studies could analyze the variations in business performance that cannot be attributed to site or scale of operation.

The third objective is to appraise the potential for the expansion of freshwater aquaculture in the Mid-Atlantic states. "Aquaculture production, through the farming of aquatic plants and animals, is expected to increase to around 22 million tons in the next decade, double the 1985 level."[1] Aquaculturists in the Mid-Atlantic states will contribute to this growth. The successes of current producers and the realities of seafood supply projections are likely to entice more people into the business. Expansion will occur along two lines: undeveloped water supplies will be put to use by aquaculturists employing traditional pond and raceway technologies; and water recirculation systems will attract an increasing number of adherents as, bit by bit, the technology is improved.

The results of the survey and interviews indicate that the Mid-Atlantic aquaculture industry is poised at a juncture between two stages of growth. The majority of existing enterprises use traditional pond and raceway technologies. These fish farmers have a broad range of production and marketing strategies, and they appear, on the whole, to be

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[1]FAO Director-General, Edouard Saouma as quoted in the "Headlines" section of Aquaculture Magazine, Vol. 15, No. 5, September/October 1989, p. 20; no author is cited.

operating profitable businesses. Survey participants plan to expand to 125% of current output levels by 1995. Few sites in the Mid Atlantic States that are endowed with water of optimal quality and significant quantity remain unused. Securing the rights to utilize those water sources not already reserved for other uses appears to involve protracted negotiation with state environmental conservation agencies. The development of these sites and the expansion of existing facilities (within the limits imposed by site water availability) will conclude the first stage of growth in regional aquacultural production. Strategies exist for utilizing low volume water supplies with traditional raceway technologies for high value, high service sales. The fish distribution enterprise described in this study is an example. However, such enterprises describe a market niche. They will never contribute greatly to the total supply of farmed fish.

Most analysts of the situation agree that the greatest hope for the significant expansion of freshwater finfish aquaculture in the Northeast lies in water recirculation technologies. As adoption of water reuse systems increases, the second stage in the growth of regional production will begin. A handful of individuals in the region are using recirculation systems of their own design. One or two researchers are attempting to perfect the technology for sale to interested investors and culturists. None of these systems has been up and running long enough to prove itself economically feasible or even technically reliable. For this reason a number of survey respondents have expressed dissatisfaction with recirculation technology. It is unlikely that water resuse systems will be widely used in conjunction with more traditional grow-out technologies. Aquaculturists who adopt the technology will probably take advantage of the siting flexibility (and the attendant market advantages) that the water reuse systems confer.

While the growth of regional production itself is relatively assured, a number of constraints external to the actual grow-out of fish threaten to slow the rate of growth. Financing for water recirculation enterprises may be difficult to obtain. Aquaculture in general is perceived as high risk. Relatively unproven technologies are not likely to reduce traditional lenders' concerns. Venture capital and state government grants are probable sources of initial support.

Beyond financial constraints lies a morass of state and federal regulations. These affect the entire industry regardless of culture technology. As the variety of species produced in the region increases, the Lacy Act and state laws which restrict the taking of live fish across state lines, and which were originally passed to protect the integrity of wild fisheries, will present more of an obstacle. Other legislation regulating fish farm effluents, requiring disease certification, and imposing difficult licensing procedures hamper the development and commerce of aquaculture.

Questions exist regarding the market for regional aquaculture products. The shortfall of the total fresh fish supply has been documented. However, the ability of regional aquaculturists to successfully compete for this market is uncertain. Producers in other regions of the United States and in other countries are able to realize greater production efficiencies. They can therefore bring their products to market at lower prices. The regional specialization of aquaculture production (in areas with optimal climate and resource conditions for the grow-out of specific species) has already occurred to a high degree. This is a natural development common to all forms of agriculture. Presently, local aquaculturists compete with high-volume producers from outside the region by offering fish of greater freshness for a higher price. Selling at a premium is frequently essential to a firm's bottom line. The extent to which local consumers will choose freshness over price in making their purchase decisions is undetermined. Regional aquaculturists are servicing a niche market. This will remain the case unless and until production and marketing costs can be reduced to make regional aquaculture more competitive, or until production in other areas reaches its upward limit (as has been suggested with the production of trout in Idaho).

Few of the Mid-Atlantic culturists surveyed are attempting to grow-out species other than trout. A couple of producers are raising salmon; another two are growing tilapia, and two fish farmers are raising catfish. In simple flow-through systems prevailing low water temperatures prohibit the culture of most species. Again, recirculation technologies hold the greatest promise for production diversification. With proper design, even the culture of shrimp may be technically feasible. However, one of the greatest questions regarding recirculation technology is economic feasibility. Increasing production diversity will expand the market niche, but high production costs are not likely to relax the necessity of niche marketing. Barring the advent of breakthroughs which allow direct competition with high-volume producers, the size of this niche is likely to determine the rate of growth in regional production.

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